Signal processing techniques for similarity checks between the pattern

1) Cross correlation

- measure of similarity of two series as function of displacement of one relative to other
- ranges from -1 to + 1

2) dynamic time warping (dtw)

- way of comparing two temporal sequences that don't perfectly sync up through mathematics
- uses adaptive time normalization to create warping path for audio sequences with diff length and speeds
- every index from the first sequence must be matched with one or more indices from the other sequence

3) fast Fourier transform

- decomposes the original sequence of length N into a series of short sequence
- transform signals from time domain to frequency domain
- frequency components can be used to identify similarity

4) wavelet transform

- efficient method for evaluating small waves
- include two transformation techniques - continuous wavelet transform and discrete wavelet transform.
- decomposes signal into a set of basis functions contractions, expansion, translation of a mother function called wavelet
- these wavelets can be used to analyse at various scales.

5) short time Fourier transform

- compute Fourier transform of short, overlapping windows of the signal to analyse frequency over- time.
- used to determine sinusoïdal frequency and phase content of local sections of a signal
- compared to fast Fourier freq spectrum moves smoother & accurate

6). Auto correlation

- measures the similarity of a signal with a delayed version of itself to identify repeating patterns
- not appropriate for 2 different signals

7) spectral coherence

- measures the coherence between 2 signals in the frequency domain to identify common frequency components
- commonly used to estimate power transfer between input and output of a linear system
- coherence measures the degree of linear dependency of 2 signals by testing for similar frequency components

8) SVD

- decompose the data matrix into its constituent parts to identify common patterns.

$$X = U \cdot S \cdot V^T$$

- X → Data matrix
- U → orthogonal matrix
- S → Diagonal Matrix
- V^T → Right Singular Matrix

Used for dimensionality reduction, pattern recognition, noise reduction & anomaly detection

9) principal component analysis.

- identify similarity by reducing the dimensionality of data while preserving information
- similar datasets will have similar principal components

10) dynamic mode decomposition

- data driven analysis used to decompose complex, non-linear systems into set of modes revealing underlying pattern & dynamics through spectral analysis

11) empirical mode decomposition

- decompose signals into a set of oscillatory components called intrinsic mode functions to analyse similarities
- more useful for non stationary type of signal
- in fft our signal is changed from time domain to freq domain but in EMP output remains in time spectrum and is not based on sine wave and instead based on IMF
- it is amplitude and frequency modulated signal with positive and slowly varying envelopes
- we apply hilbert transform to IMF to perform spectral analysis.

12) envelope analysis

- targets amplitude variation in vibration signal
- has 3 steps:
- shift the band range in high freq band to base band
- filtering the freq shifted signal using low pass filter and calculates the envelope signal of low pass filtered signal
- these envelopes of signal are used to compare the trend

13) hilbert transforms

- compute instantaneous frequency and amplitude of signal to analyse similarity in time frequency domain
- imparts a phase shift of + or - 90 to every freq component of A function
- the rapid oscillations can be removed from signal to produce a direct representation of envelope

14) cosine similarity

- compare the similarities btw different data points or signals by measuring cosine of the angle between 2 signals & measures similarity based on orientation of the signal

15) symbolic Aggregate approximation:

- approx time series data as a sequence of symbols
- reduce dimensionality while preserving important characteristics
- reduce index dimension by using the boundary distance measure which is lower than Euclidean distance

16) symbolic bispectra based Lempel ziv complexity

- combines symbolic representation with bispectral analysis which examines the interaction btw different freq. components of data